

IN THE SPECIFICATION:

Please replace paragraph [0011] with the following amended paragraph:

[0011] Embodiments of the invention generally provide an electrochemical plating apparatus configured to plate copper onto semiconductor substrates, while minimizing the depletion of organics during ~~non-processing~~ non-processing time periods. The apparatus generally includes a plating cell configured to contain a plating bath, a substrate support member positioned above the plating bath and being configured to selectively contact the plating bath with a substrate secured thereto, and an electrolyte fluid supply line in fluid communication with the plating bath. Additionally, the plating apparatus may include a selectively actuated check valve positioned in the electrolyte fluid supply line, and an electrolyte bleed line in fluid communication with the plating bath.

Please replace paragraph [0012] with the following amended paragraph:

[0012] Embodiments of the invention further provide a method for reducing organic depletion in an electrochemical plating system during non-processing time periods. The method generally includes the steps of closing an electrolyte feedline now in order to isolate a plating cell from electrolyte supplied during a ~~non-processing~~ non-processing time period, and draining at least a portion of the remaining electrolyte solution from plating cell by opening a bleed valve in fluid communication with the plating cell.

Please add the following new paragraphs after paragraph [0019]:

[0019.1] Figure 6 illustrates a sectional view of the exemplary substrate support assembly illustrated in Figure 5.

[0019.2] Figure 7 illustrates an exemplary depletion determination and processing recipe modification method of the invention.

Please replace paragraph [0021] with the following amended paragraph:

[0021] Figure 4 is a cross sectional view of an exemplary electroplating process cell 400 of the invention. The electroplating process cell 400, for example, may be implemented into the process cell location 240 illustrated in Figure 3. Process cell 400 generally includes a head assembly 410, a process kit 420, and an electrolyte collector 440. Preferably, the electrolyte collector 440 is secured onto the body 442 of the mainframe 414 over an opening 443 that defines the location for placement of the process kit 420. The electrolyte collector 440 includes an inner wall 446, an outer wall 448, and a bottom 447 connecting the respective walls. An electrolyte outlet/overflow 449 may be disposed through the bottom 447 of the electrolyte collector 440 and connected to an electrolyte replenishing system 480 through tubes, hoses, pipes, or other fluid transfer connectors. The outer wall 421 of process kit 420 defines an open top enclosure 475 configured to contain ~~and~~ an electrolytic plating solution therein. Enclosure 475 includes an electrolyte supply line 476 that is generally in communication with an electrolyte supply or storage unit and includes a check valve 477, which may generally operate to selectively terminate electrolyte flow-through supply line 476. Supply line 476 is generally configured to supply electrolyte from a storage container to the processing enclosure 475. Enclosure 475 may further include an electrolyte bleed line 478, which may be in fluid communication with enclosure 475 and positioned vertically within the outer wall 421 of enclosure 475 at a level just above an upper surface of an anode 470 positioned within enclosure 475. Bleed line 478 may include a selectively actuated valve 479, which may be used to initiate bleed line flow of electrolyte out of enclosure 475. Bleed line 478 may be in fluid communication with a fluid drain, or alternatively, bleed line 478 may be in communication with the storage/replenishment device mentioned above.

Please replace paragraph [0024] with the following amended paragraph:

[0024] A depletion rate determination process generally includes executing at least one test run of the plating system to determine the depletion rate of specific organic molecules from the plating solution as a function of the current density applied in the plating process. For example, in a plating system where the current density applied during plating operations is generally between 10 A/cm² and 15 A/cm², the test run process may include an incremental test of current densities between 10 and 15 A/cm². This type of test run process, for example, may include plating a substrate at 10 A/cm² for a predetermined period of time, and then measuring the depletion of organic molecules from the electrolyte solution at the end of the predetermined period of time. Once the depletion of organics for the tested current density is measured/known for the given current density over the predetermined unit of time, the depletion of the organics per individual unit of time for the given current density may be determined through calculation, assuming that the initial or starting organic concentration is known before the test run process is commenced. The calculation process, for example, may determine an organic concentration differential, *i.e.*, the difference between the organic concentration before the test run and the organic concentration after the test run, and then use the concentration differential to determine the volumetric depletion of organics during the test run process. Once the volumetric depletion is determined, it may be divided by the test run duration to determine the volumetric depletion per unit time. Therefore, for example, if a test run measurement of plating at 10 A/cm² for 20 units of time determines that 40 volumetric units of a specific organic molecule (organic "A") are depleted during the 20 units of time, then it may be determined/calculated that the depletion of organic A per unit of time for a current density of 10 A/cm² is 2 volumetric units per unit of time. This test, measure, and calculate process may then be incrementally repeated for various current densities within the range of normal operation of the particular plating system. For the exemplary system noted above that generally operates in the 10 A/cm² to 15 A/cm² range, test runs may be executed at 11 A/cm², 12 A/cm², 13 A/cm², 14 A/cm², and 15 A/cm², for example, wherein each test run may be conducted for a predetermined time interval.

Please replace paragraph [0027] with the following amended paragraph:

[0027] Using a current density of 10 A/cm^2 as an example, the plating system may be run with the current density of 10 A/cm^2 for 20 units of time. Once the 10 A/cm^2 test run is complete, the plating solution in the plating system may be measured to determine the remaining concentration of organics in the plating solution. Using the measured organic concentration, the volumetric depletion of the organics may be determined. For example, in the 10 A/cm^2 test run, it may be determined that 40 volume units of organics were depleted from the solution during the 20 units of time of the test run. Therefore, using this information, the method of the invention may then calculate the volumetric depletion of organics per unit time for a current density of 10 A/cm^2 , which is illustrated as 2 volumetric units of organics depleted per unit of time (40 volumetric ~~units~~ units depleted divided by 20 units of time yields 2 volumetric units depleted per individual unit of time). This process may then be repeated for various other current densities. In the exemplary method illustrated in Figure 7, the current density test runs are repeated for current densities of 11, 12, 13, 14, and 15 A/cm^2 , each using a time duration of 20 units of time. However, although 20 units of time are illustrated for each current density test run in the exemplary method illustrated in Figure 7, it is not necessary or required for the test run time duration to be identical for each test run. Rather, the time duration may be varied per current density test run in order to increase the efficiency of the individual run, *i.e.*, if depletion for a particular current density may be accurately measured in a shorter time duration, then the duration may be shortened. Similarly, if a particular current density requires a longer test run duration in order to obtain an accurate depletion measurement, the time duration may be lengthened to accommodate an accurate measurement.

Please replace paragraph [0033] with the following amended paragraph:

[0033] In another embodiment of the invention, depletion of organics during non-processing time periods may be minimized. For example, ~~as illustrated Figure 8,~~ a method for reducing depletion of organics during non-processing time periods may

include the steps of isolating the processing cell 804 and draining the process cell 802. The isolation step 804 generally includes closing a check valve positioned in the electrolyte supply line, *i.e.*, in the line supplying fresh electrolyte to the processing cell for processing. For example, referring to the exemplary plating apparatus 400 illustrated in Figure 4, check valve 477 may be closed in order to terminate the flow of fresh electrolyte into processing region 475 during non-processing time periods. Therefore, with check valve 477 closed, processing region 475 is generally isolated. Once processing region 475 is isolated, a substantial portion of the remaining electrolyte solution contained within processing region 475 may be drained therefrom. For example, again referring to the plating apparatus 400 illustrated in Figure 4, a substantial portion of the electrolyte solution contained in processing region 475 may be removed therefrom by bleed line 478. The removal process generally includes opening a bleed valve 479 such that the electrolyte solution contained within processing region 475 may be allowed to flow out bleed line 478. Bleed line 478 may be in communication with a fluid drain, an electrolyte replenishment device, or an electrolyte storage cell, for example. Assuming bleed line 478 is positioned in the sidewall 421 of processing region 475 just above anode 470, within bleed line 478 may operate to remove a substantial portion of the electrolyte solution from processing region 475, while leaving enough electrolyte solution to maintain the anode 470 in solution. Therefore, assuming the volume of processing region 475 is approximately two liters, bleed line 478 may be used to remove approximately 1 to 1/2 liters of electrolyte solution therefrom. When a substantial portion of the electrolyte solution contained within processing region 475 has been removed, then bleed valve 479 may be closed to again isolated processing region 475. Alternatively, if anode 470 does not need to be maintained in solution, then bleed line 478 may be positioned in the bottom of the electrolyte container so that substantially all of the electrolyte may be drained from the electrolyte container during non-processing time periods.